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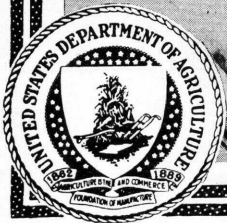
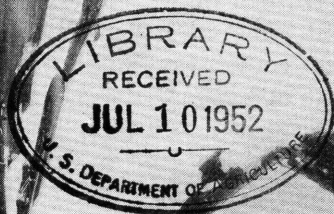
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# U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1691

## HOW TO CONTROL GRASSHOPPERS in CEREAL and FORAGE CROPS



ALTHOUGH the farmer usually does not notice grasshoppers until they have reached a considerable size, they begin to injure his crops soon after they hatch. They should therefore be detected and combated while they are young and small, so that time, labor, and material, as well as crops, may be saved.

Destroying grasshopper eggs by fall plowing, disking, or harrowing is recommended where such destruction is practicable.

Applying poisoned bait is the most practical means of controlling grasshoppers. The poisoned bait should be put out usually between 6 and 10 a. m., or as soon after sunrise as air temperatures reach 70° to 80° F. At these times the grasshoppers are on the ground doing their first feeding of the day. The bait should not be put out while the temperature is below 70° or above 85° or during inclement weather.

In mixing and distributing the poisoned bait care should be taken to prevent injury to persons or farm animals.

The best results can be obtained when all the farmers in a community cooperate.

This bulletin is a revision of and supersedes Farmers' Bulletin 747, Grasshopper Control in Relation to Cereal and Forage Crops.

# HOW TO CONTROL GRASSHOPPERS IN CEREAL AND FORAGE CROPS

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GRASSHOPPERS have always been among the principal insect enemies of agriculture. Serious outbreaks still occur over large areas at irregular intervals, and the aggregate annual loss due to grasshoppers even during years not marked by outbreaks is sufficient to class these insects as a major pest.

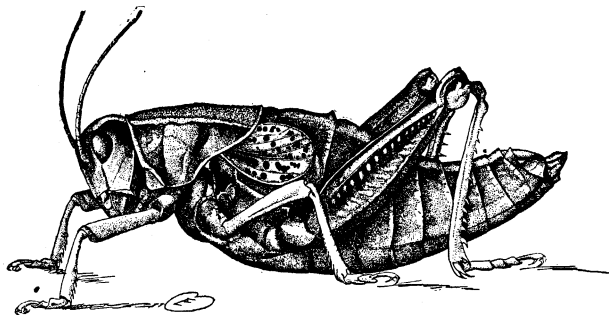


FIGURE 1.—Southwestern lubber grasshopper. Adult female. Natural size.

## PRINCIPAL KINDS OF INJURIOUS GRASSHOPPERS

Many kinds of grasshoppers injure grains, grasses, and forage crops throughout the United States. The most important are the southwestern lubber, the differential, the two-striped, the lesser migratory, the red-legged, the Carolina, and the pellucid or clear-winged grasshoppers.

The southwestern lubber grasshopper (*Brachystola magna* Gir.) (fig. 1) is very large, usually pale green, speckled, and marked with pink and brown, and is wingless throughout its entire life. This species lives in the semiarid regions of the Southwest. It sometimes becomes injuriously abundant on the cattle ranges and dry farms

of New Mexico and Arizona, but is found throughout the Great Plains area from Wyoming and South Dakota to New Mexico and Texas.

The differential grasshopper (*Melanoplus differentialis* Thos.) (fig. 2) is usually yellowish, with clear, glassy hind wings, and

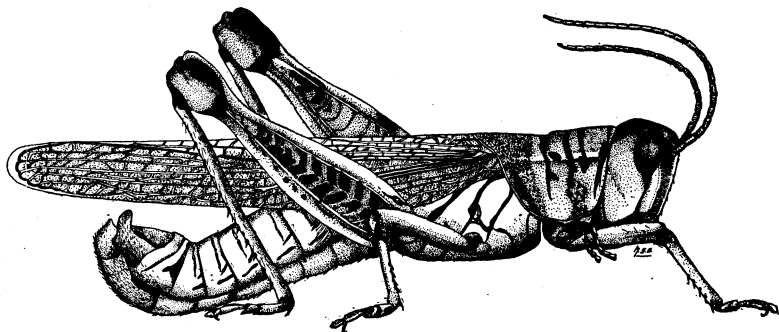


FIGURE 2.—Differential grasshopper. Adult male. Twice natural size.

averages nearly  $1\frac{1}{2}$  inches in length. Its hind legs are usually distinctly marked with yellow and black, the color arranged in chevron-shaped bars on the sides of the thighs. It is found throughout nearly the entire United States, although rarely in the Atlantic States. This grasshopper is chiefly injurious in the Middle Western and Southwestern States.

The two-striped grasshopper (*M. bivittatus* Say) (fig. 3) is compact and yellowish, bearing two yellow stripes from the forehead

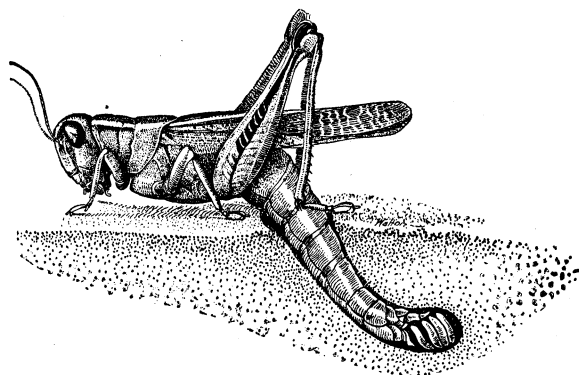


FIGURE 3.—Two-striped grasshopper laying her eggs. Natural size.

down each side of the otherwise brown back, and having nearly colorless hind wings. It ranges from 1 to  $1\frac{1}{2}$  inches in length. This species is found from southern Canada to Mexico, except in the South Atlantic States.

The lesser migratory grasshopper (*M. mexicanus* Sauss.) (fig. 4) is reddish brown, bearing a distinct patch of black on the neck or collar and averaging about 1 inch in length. Although comparatively small, it is a strong flier and sometimes does immense damage

to crops. It is found throughout nearly the entire United States but is chiefly injurious in States west of the Mississippi River.

The red-legged grasshopper (*M. femur-rubrum* Deg.) (fig. 5) is one of the most widely distributed of all the injurious species.

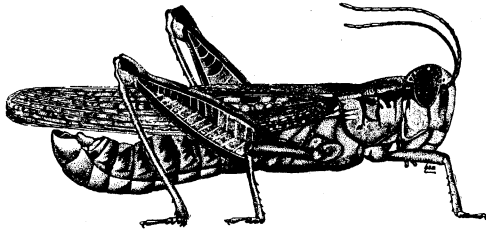


FIGURE 4.—Lesser migratory grasshopper. Adult male. Twice natural size.

It is small, reddish brown above and yellow beneath. Its legs are partly tinged with a bright red, and its hind wings are colorless. It is found in considerable numbers throughout the entire United States, southern Canada, and northern Mexico.

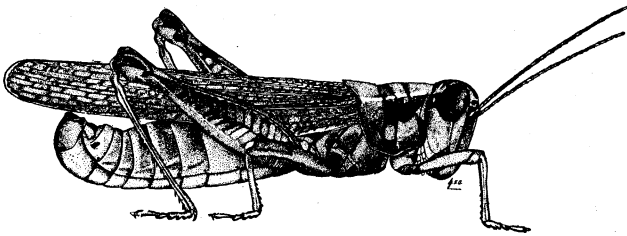


FIGURE 5.—Red-legged grasshopper. Adult male. Twice natural size.

The Carolina grasshopper (*Dissosteira carolina* L.) (fig. 6) is of medium to rather large size and is usually of a plain pepper-and-salt color, sometimes varying from gray through yellowish to a distinctly reddish color depending upon the soil upon which it is found. Its

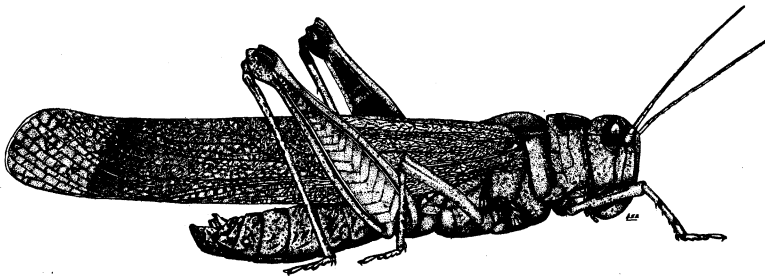


FIGURE 6.—Carolina grasshopper. Adult male. Twice natural size.

hind wings are nearly black, margined with yellow. Thus it is inconspicuous while sitting upon the ground but catches the eye immediately upon taking flight. It is very widely distributed throughout the United States.

The pellucid or clear-winged grasshopper (*Camnula pellucida* Scudd.) (fig. 7) is small, and its hind, or true, wings are clear or pellucid, whereas the front wings are distinctly blotched with brown. It is distributed throughout the Northern States from the Atlantic to the Pacific, and is at times one of the most injurious species in the United States.

Grasshoppers, both young and old, injure crops in but one way, by gnawing and devouring them wholesale. Where very numerous, they have been known to consume almost every green thing in sight (fig. 8), even eating the bark on the tender twigs of trees and gnawing the handles of hoes and rakes in order to secure the salt left there by perspiring hands.

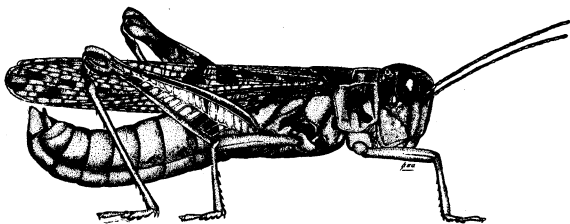


FIGURE 7.—Clear-winged grasshopper. Adult male. Twice natural size.

### CONDITIONS FAVORABLE TO OUTBREAKS OF GRASSHOPPERS

It is generally believed that dry, warm weather is favorable for grasshoppers, and it is known that the most severe outbreaks have occurred either during or following periods of drought. Wet weather is unfavorable, and great numbers of grasshoppers often die from disease under such conditions. Many years ago attempts were made to control grasshoppers by spreading disease among them, but it was found that both fungous and bacterial diseases developed of their own accord during wet weather but always failed to thrive under dry conditions. Cool weather during the egg-laying period decreases the number of eggs laid. Winter temperatures have little effect upon grasshopper abundance.

### LIFE HISTORIES AND DEVELOPMENT OF GRASSHOPPERS IN GENERAL

The life histories of the various species of injurious grasshoppers are quite similar. The eggs are usually deposited in the soil, inclosed in sacs, or "pods," formed of a glutinous substance furnished by the female. The grasshopper thrusts her abdomen, which is capable of considerable extension, into the soil (fig. 3) and starts laying her eggs at the farther end of the tunnel thus formed, which is then filled with eggs and sealed. One grasshopper has been known to deposit as many as 441 eggs.

Egg laying usually takes place in late summer or early fall, and the young grasshoppers emerge the following spring. In some of the Southern and Southwestern States the young grasshoppers may



emerge as early as February, but in the North the eggs usually do not hatch until May or June.

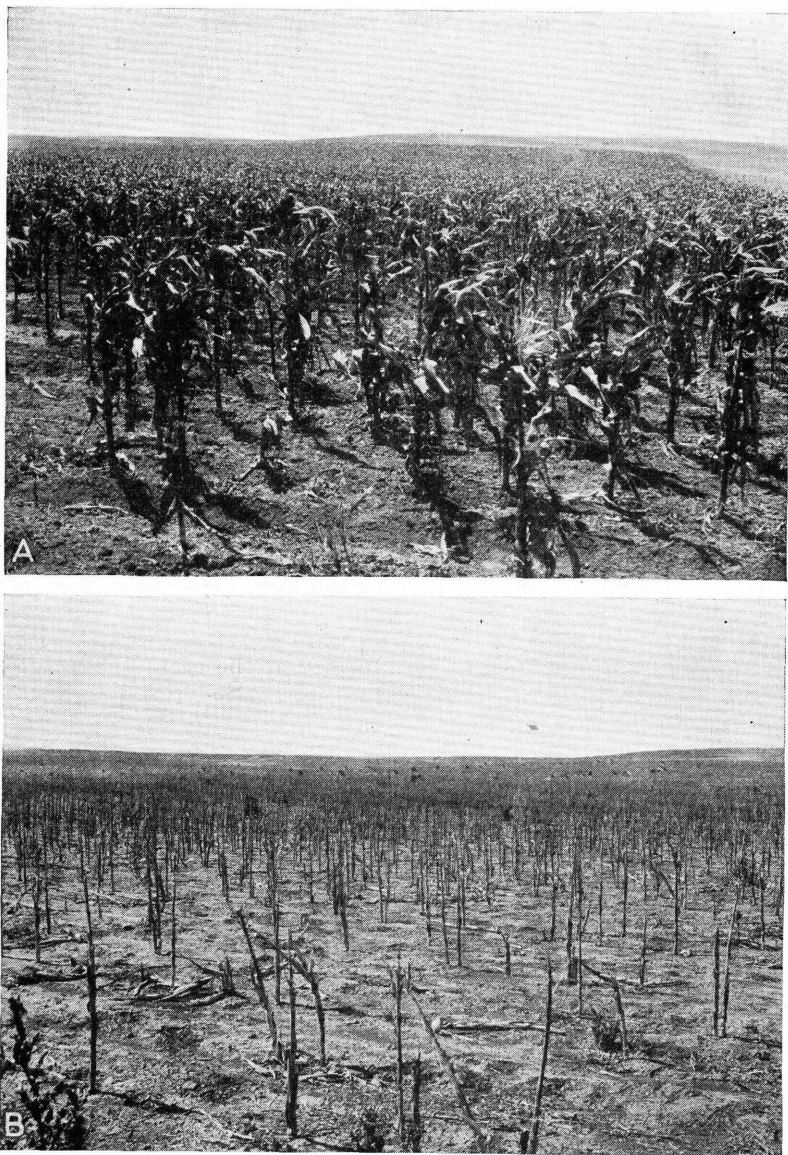


FIGURE 8.—These photographs show how grasshoppers may ruin corn. A, An army of adult differential and two-striped grasshoppers is entering the corn at the edge of field shown in the foreground; B, the same field a few days later, after the grasshoppers have passed through it. In many cornfields in the immediate vicinity every stalk was devoured to the ground.

In contrast to many other injurious insects, grasshoppers, when newly hatched, closely resemble their parents, except that they lack wings. There is no grublike larval stage, nor is there any resting or



true pupal stage, such as that of butterflies and moths. The young grasshoppers are active and are able to hop almost immediately upon emergence from the eggs. They require from 40 to 60 days to grow into maturity and develop wings. During this time they shed their skins five or six times. The cast-off skins are often mistaken for dead grasshoppers and frequently are the basis of mistaken reports that grasshoppers are "dying by the millions." The appearance of wings, except in the wingless species, marks the final stage of growth, and the grasshopper is then ready to mate and reproduce. There is only one main generation a year, with sometimes a partial second.

### NATURAL ENEMIES

Several kinds of parasitic two-winged flies deposit maggots upon grasshoppers in their mature or nearly mature stage. Among the most important of these is a flesh fly, which has been observed to deposit live maggots upon the grasshoppers while they are in flight.

The maggot devours the internal portions of the grasshopper's body and soon causes its death. Robber flies feed very largely upon young grasshoppers, grasping them with their long, stout legs, thrusting their strong beaks through the body walls of the grasshoppers, and sucking out the liquid contents of the bodies. Several kinds of digger wasps kill or stupefy grasshoppers by stinging and then drag them into their underground nests. The wasp then lays an egg upon the body of the grasshopper, which subsequently becomes food for the newly hatched grub. A number of blister beetles are known to prey in their young stages upon the eggs of grasshoppers, but as the adult beetles are sometimes quite injurious to potatoes, beans, and other cultivated plants, they cannot be considered as entirely beneficial.

The Bureau of Biological Survey has found that birds play an important part in the natural control of grasshoppers. All birds except the strictly vegetarian doves and pigeons feed on grasshoppers and destroy large numbers of them, but they cannot be expected to prevent outbreaks. It has often been asserted that the reason grasshoppers are so abundant at the present time is that game birds are less numerous than formerly. It should be remembered, however, that the worst grasshopper outbreaks in the history of American agriculture occurred in the Great Plains region 50 to 60 years ago, when game birds were far more plentiful than they now are.

### CONTROL MEASURES

Two principal methods of control have been found to be of practical value in combating grasshoppers in this country: (1) Destruction of the eggs; and (2) use of poisoned baits.

#### DESTROYING GRASSHOPPER EGGS

Where grasshopper eggs are laid in ground that can be economically plowed or harrowed, great numbers of them can be destroyed by these operations. The lesser migratory grasshopper, when abundant, lays great numbers of eggs around the roots of the current year's grain crops. Plowing and packing the stubble fields either in the fall or

early in the spring delays the hatching of the eggs and prevents the young grasshoppers from reaching the surface. The two-striped and the differential grasshoppers most often lay their eggs in sod land and weedy ground around the edges of forage and cereal crops. Plowing or disking headlands and ditch banks may destroy great numbers of the eggs. The clear-winged grasshopper concentrates its eggs in overgrazed pastures, wild-hay meadows, and in sod land along roadsides. To plow or disk such land is expensive and ruins it for grass production. Under such conditions egg destruction becomes impractical.

When land that contains grasshopper eggs is plowed, the soil should be turned to a depth of at least 6 inches; it should then be harrowed or packed. If the job is well done, the young hoppers hatching from the eggs are not able to reach the surface. Cultivating with a disk harrow breaks open many of the egg pods and brings them to the surface, where they dry out and die. Several diskings about 10 days apart are necessary to bring most of the eggs to the surface. Disking during warm, dry weather in September and October is more effective than disking in the spring.

#### USING POISONED BAIT

Use of poisoned bait has proved to be a simple, reliable, and cheap way of killing grasshoppers and is recognized by entomologists and farmers as the standard control method.

#### MATERIALS RECOMMENDED

There are many materials which have been used more or less successfully in making poisoned bait for grasshoppers. Availability, cost, and relative efficiency should be considered in making a selection. Experience gained by the extensive farm use of grasshopper bait in recent outbreaks and by experimental tests indicate that sawdust can be substituted for much of the bran previously recommended and that grasshoppers in most cases are attracted to the bait without the addition of molasses, amyl acetate ("banana oil"), citrous fruits, or other strong-smelling substances.

The following bait formulas are recommended, in the order listed:

#### MILL-RUN BRAN AND SAWDUST

Mill-run bran, mixed feed, or shorts	_____pounds	25
Sawdust (three times bulk of mill-run bran)	_____bushels	3½
Liquid sodium arsenite (32 percent arsenious oxide)	_____gallon	½
Water	_____gallons	10-12

The millfeeds recommended in this formula contain considerable quantities of flourlike material mixed with flakes of wheat bran. When moistened by the solution of water and sodium arsenite, the finer material forms a poisoned paste which coats the sawdust particles. Grasshoppers relish the flour paste, both for its food value and for its moisture content. They gnaw and chew the sawdust to obtain the paste and are killed by the poison it contains. The sawdust is not eaten after the flour coating and moisture have been completely removed. The flakes of poisoned bran generally are entirely consumed by feeding grasshoppers.

This mixture was used in the extensive grasshopper campaign of 1937 and gave excellent control at low cost under varied conditions in the western half of the United States. Its large content of sawdust greatly improves the spreading qualities of the bait, and, in combination with millfeeds other than pure bran, greatly reduces the consumption of feed materials in baits; as a result, there is less disturbance of the millfeed market during seasons when large quantities of bait materials are being purchased.

## STANDARD BRAN AND SAWDUST

Standard wheat bran	-----pounds	50
Sawdust (equal to bran in bulk)	-----bushels	2½
Liquid sodium arsenite	-----gallon	½
Water	-----gallons	10-12

Standard bran does not contain as much flourlike material as mill-run bran and other more finely ground millfeeds. It does not coat the sawdust particles as thoroughly, and the killing action is obtained largely through the consumption of poisoned bran flakes. The sawdust acts as a diluent and prevents lumping. This mixture has been widely used with good success and is recommended where other millfeeds are difficult to obtain.

Where sawdust is not available, an additional 50 pounds of wheat bran may be substituted for it. The use of the sawdust, however, results in a considerable saving in cost.

## LOW-GRADE FLOUR AND SAWDUST

Low-grade flour	-----pounds	10
Sawdust (equal in bulk to 100 pounds of bran)	-----bushels	4½
Liquid sodium arsenite	-----gallon	½
Water	-----gallons	10-12

The killing of the grasshoppers when this bait is used is due entirely to their feeding on the paste-covered sawdust particles. This bait has given good results in experimental tests conducted over a period of several years and has been used in several county-wide grasshopper-control campaigns. It is recommended where coarser millfeeds are not available or are unusually high in price.

## MOLASSES AND SAWDUST

Sawdust (equal in bulk to 100 pounds of bran)	-----bushels	4½
Molasses (low-grade cane or blackstrap)	-----gallons	1½
Liquid sodium arsenite	-----gallon	½
Water	-----gallons	10-12

The killing action of this mixture on grasshoppers results from their eating the sticky coating of poisoned molasses adhering to the sawdust particles. This bait frequently has given as good kills in experimental work as the millfeed baits, but generally was slightly below them in killing power. It is recommended when other materials are not available.

## POISONS

Liquid sodium arsenite is the cheapest and most satisfactory poison. The so-called "4-pound" material containing 4 pounds of arsenious oxide (32 percent) to the gallon is usually available commercially. One-half gallon is used for each 100 pounds of bran or equal bulk

of sawdust. This quantity is considerably in excess of the actual requirements for killing, as good kills have been obtained with half this dose, but the grasshoppers die more slowly, and great care must be taken to distribute the smaller dosage evenly throughout the bait. The greater quantity recommended gives maximum killing action and provides a margin of safety in mixing. The use of dosages larger than those recommended does not further speed up killing action or increase the total kill.

Finely divided crude arsenic, obtained from copper smelters, can be substituted for liquid sodium arsenite. Five pounds should be used for each 100 pounds of bran or equal bulk of sawdust. Crude arsenic kills more slowly than sodium arsenite; it does not dissolve in water, and more labor and care are required in mixing it to obtain a uniform distribution of poison throughout the bait.

Paris green used at the same rate as crude arsenic gives equally good results but is more expensive.

Sodium fluosilicate at the rate of 4 pounds to 100 pounds of bran, or equal bulk of sawdust, has given excellent kills in experimental work. It is less toxic to animals than arsenic, and its use would lower the hazard of accidental livestock poisoning. It costs more than either liquid sodium arsenite or crude arsenic.

#### SAWDUST

Either hardwood or softwood sawdust may be used. Coarse-sawn dust is not so effective as the finer dust. Coarse material can be greatly improved by running it through a hammer mill. Sawdust that has remained in the pile for several years has softer fiber, is more absorbent, and makes a better bait carrier than the firmer particles of new sawdust. Fresh sawdust from extremely soft woods, such as poplar, may be used without ageing. Any bark, sticks, large chips, or other useless material should be removed by screening.

#### MIXING THE BAIT

The bait can be mixed by hand on a tight floor or in a wagon box or similar container (fig. 9). In mixing sawdust and millfeed baits the required quantity of sawdust should be spread out evenly over the floor to a depth of 6 to 8 inches. The millfeed should then be scattered uniformly over the sawdust and the two ingredients thoroughly mixed by turning with scoop shovels. If one of the arsenic preparations or paris green is used the required quantities of water and poison are mixed thoroughly in a large can or barrel. This mixture is then splashed over the dry ingredients in three applications and the mixture turned with shovels after each wetting. When either crude arsenic or paris green is used the liquid must be vigorously agitated just before each portion is removed from the container, as otherwise the heavy insoluble poison will settle to the bottom and an uneven mixture may result.

Sodium fluosilicate gives best results when it is thoroughly mixed with the dry ingredients before water is added.

Twice the quantity of materials listed in each formula is about all that can be mixed in a wagon box at one time, but on a floor

where there is plenty of room the quantity can be doubled again. Good results depend on mixing the mash thoroughly until it contains no lumps, and is uniformly moist throughout. The quantity of water needed will vary somewhat according to the condition of the sawdust used. It is desirable to add as much water as the bait



FIGURE 9.—Mixing poisoned bait. The water and arsenic are being mixed in the large can in the center of the picture.<sup>1</sup>

will absorb and still fall in individual flakes when scattered by hand. A good test for correct moisture content is to squeeze a handful of bait. If it drips moisture freely when lightly gripped, it is too wet. Properly moistened bait will drip only slightly when pressed firmly in the hand.

In county-wide campaigns where many tons of bait must be mixed, the best results can be obtained by establishing a central mixing station. A small crew properly supervised and using mechanical bait-mixing machines can prepare a more uniform bait at less cost than it can be mixed by hand on individual farms.

#### METHODS OF DISTRIBUTION

The prepared mash should be thinly and evenly scattered over infested fields at the rate of 10 to 20 pounds (wet basis) per acre. It is most commonly spread by hand. Every precaution should be taken to see that it falls apart into flakes. Casting it into the wind with a snap of the wrist will help to accomplish this. Several casts should be made with one handful of bait. When large quantities of bait are to be distributed, scattering from the rear end of a wagon or

<sup>1</sup> Figures 9 and 10 were supplied through the courtesy of C. J. Drake, of the Iowa Agricultural Experiment Station.



truck (fig. 10) permits two men to scatter at one time as the vehicle is driven slowly over the field. One man scattering from a wagon can cover 10 acres per hour; two men in a truck can cover 20 acres. An end-gate seeder can be used but must be carefully watched and not allowed to clog because of too rapid feeding.

Recently a number of inexpensive home-made or locally made bait-spreading machines have been developed with which from 30 to 40 acres can be covered per hour. In one of the better types a circular disk 3 feet in diameter is mounted on an upright shaft so that the disk is 5 feet above the ground. The disk is fitted with raised vanes



FIGURE 10.—Scattering poisoned bait from the rear end of a motortruck.

and is whirled rapidly by power from traction gears or a motor. Bait from a container is fed automatically upon the revolving disk and, when struck by the vanes, is thrown with great force in a swath 30 to 40 feet wide, falling in evenly distributed flakes. Working plans and specifications for bait spreaders can be obtained from some of the agricultural colleges in the infested area. Figure 11 shows a type of spreader that can be made by utilizing the rear end of an old automobile for both support and power, the original drive shaft serving to operate the larger pulley, which is belted to a small pulley under the disk.

The use of mechanical spreaders decreases the cost of spreading the bait and makes possible the treatment of large acreages during the comparatively short period of the day favorable to bait spreading.

When large, uniformly infested areas, difficult of access by wagon or truck are to be treated, scattering by airplane is practical. Airplanes fitted with special equipment can cover 100 to 150 acres per hour. Their use in the United States has not been extensive because all available funds for grasshopper control are generally expended for materials, and the labor for spreading is usually provided by the land owners or tenants.

#### TIME OF DISTRIBUTING BAIT

The poisoned bait should be put out while the grasshoppers are on the ground, doing their first feeding of the day. This occurs as

soon after sunrise as the air temperature reaches 70° to 80° F., usually between 6 and 10 a. m. The bait should not be put out when the temperature is below 70° or above 85°, or during inclement weather. An exception to this rule can be made with grasshoppers that are migrating. Under such conditions they feed greedily on poisoned bait scattered across the line of march, regardless of time and temperature.

Newly hatched grasshoppers usually remain for some time congregated on their hatching grounds. They should be poisoned while they are still confined to these places or before they have invaded



FIGURE 11.—An inexpensive home-made bait spreader that utilizes the rear end of a discarded automobile as the source of power.

crops. It is important to realize that the use of poisoned bait is far more effective when young grasshoppers are concentrated along headlands than after they have increased in size and are dispersed over an entire field. Fighting grasshoppers before they attack or at the time they first invade crops is one essential of a successful control campaign.

Grasshoppers do not die immediately after they have eaten the poisoned bait. The poison may require 24 hours or even longer to become fully effective. It usually makes grasshoppers sick within a few hours, however, and they do little damage after having eaten a fatal dose.

#### PRECAUTIONS NECESSARY IN HANDLING ARSENIC AND POISONED BAIT

Unless reasonable precautions are taken during the mixing and scattering of grasshopper bait, arsenical injury may result. Crude arsenic is a fine powder that floats in the air, and when mixing is done indoors it frequently impregnates the clothing and comes in



contact with the skin of workers engaged in mixing bait. Continued contact with dry arsenic may cause acute skin irritation. To prevent this, the following simple precautions are recommended: (1) a complete change of clothing and a bath after each day's work; (2) daily washing of garments worn while mixing bait; (3) wearing outer clothing that consists of firm-texture coveralls, heavy shoes (not oxfords), and gauntlet-type leather gloves, with soft cotton gloves inside. The coveralls should be fastened tightly around shoe tops and wrists and should have pockets sewed shut.

When liquid sodium arsenite is used there is less danger of skin irritation during the bait-mixing process, but continued contact with the moist bait may result in burns if workers are careless. For workers in mixing stations where liquid sodium arsenite is used the following precautions are recommended: (1) Grease the hands frequently with petrolatum, lanolin, or axle grease and work it under the fingernails; (2) wear heavy rubber or well-oiled leather gloves; (3) if lifting sacks of wet bait wear waterproof aprons; (4) if clothing becomes damp from contact with bait, remove and wash it thoroughly before wearing it again; (5) bathe the entire body thoroughly after each day's work.

Regardless of precautions, some workers are sure to be careless, and occasionally inflammation and burning of the skin are to be expected. Slight irritation can generally be relieved by treatment with zinc oxide ointment, calamine lotion, or a saturated solution of sodium thiosulphate. Cuts and bruises are often irritated by arsenic. They should be cleaned with sodium thiosulphate solution, followed by alcohol, and then given a protective coating of collodion. Any cases which do not respond immediately to ordinary treatment should be referred to a physician.

In spreading bait, long-continued handling of the wet mash may result in irritation of the hands, particularly underneath the fingernails, and inflammation of the lower abdomen and legs may occur if clothing becomes dampened by contact with the sack or pail in which the bait is carried. Greasing the hands, working the grease beneath the fingernails, wearing a canvas or rubberized apron, and avoiding dampening of the clothing by contact with the bait will prevent such effects. After spreading is finished, the hands should be thoroughly washed with soap and water; and if clothing has been wet by contact with the bait, the entire body should be bathed. Bait spreading is done every year by thousands of farmers, and to date no cases of serious injury have been reported.

Mixed-bait containers should be labeled "POISON" in large letters. The bait should never be left on wagons or trucks where horses or cattle can break open or lick the sacks containing it, and it should be stored in a building inaccessible to livestock and children.

Poisoned bait scattered in flakes is never picked up by livestock in sufficient quantities to cause poisoning. When bait is scattered at the usual rate of 20 pounds of wet mash per acre, less than half a pound of arsenic ( $\text{As}_2\text{O}_3$ ) is spread over 1 acre, and less than a quarter of a pound when liquid sodium arsenite is used. To obtain a fatal dose, a horse would have to eat every bit of bait on 461 square yards and a sheep all the bait on 115 square yards. Considering the difficulty that the animal would have in finding the small flakes of

bran and sawdust and that much of the bran is eaten immediately by grasshoppers, the possibility of livestock poisoning is exceedingly remote where bait is properly scattered. If it is scattered in lumps and in larger quantities per acre than those recommended, animals may eat it with disastrous results. Farm animals have been killed by uncovering and eating left-over bait that had been buried in bulk months before in strawstacks and in the ground. Unused bait stored on the farm has sometimes been fed directly to livestock by careless farm laborers. Poisoned bait remaining after the baiting season is over should be stored in a county warehouse or scattered thinly over the ground in the same manner as when grasshoppers are present. The storing of unused bait on the farm during the winter months involves a hazard both to human beings and to animals. Sacks which have contained the bait should be returned to the county mixing station or burned and the ashes buried in the ground. Drums that have contained sodium arsenite should not be used for hauling water for livestock.

#### GRASSHOPPER BAIT NOT DANGEROUS TO GAME BIRDS AND SONG BIRDS

Contrary to a widespread public impression, game birds and songbirds are not endangered by grasshopper-bait-spreading campaigns.

In Iowa employees of the State College, the Bureau of Biological Survey, United States Department of Agriculture, and the State conservation commission, in cooperation with the American Wildlife Institute, kept a close check on 600 farms during the extensive poisoning campaign of 1936. Four hundred farms were moderately or heavily baited, but not a single game bird, song bird, rabbit, or other wild animal was observed to have died as a result of eating poisoned bran or poisoned grasshoppers. Instead, it was found that grasshoppers, where not controlled, destroyed the cover and winter food (weed seed, berries, etc.) of game birds, and the birds moved to other sections.

During the extensive grasshopper-baiting campaign in South Dakota in 1931 and 1932 there were numerous rumors of birds being killed by grasshopper bait. The Bureau of Biological Survey placed a man in the State during the summer of 1932 to investigate such reports and to check baited farms for sick or dead birds, but he was unable to find an authentic case of poisoning.

F. E. Whitehead, of the Oklahoma Agricultural Experiment Station, has made extensive experiments in feeding poultry, quail, and songbirds both grasshopper bait and poisoned grasshoppers. He found that it required a surprisingly large quantity of arsenic to kill such birds and that even when they fed to capacity on bait or poisoned grasshoppers they did not obtain a toxic dose. Even when domestic poultry were confined in pens where bait was scattered at the rate of 100 pounds to the acre, or 10 times the amount used in grasshopper control, and were given no other food, none died.

During the extensive grasshopper campaigns conducted from 1934 to 1937, county agents in every county where poisoned bait was used were requested to watch for and investigate any reported cases of killing of game birds or song birds. Not a single proved case was reported.

### ADDITIONAL SUGGESTIONS FOR CONTROL

#### BARRIER STRIPS

When young grasshoppers are hatching in sod land adjacent to a crop likely to be attacked, their advance into the crop can be retarded by plowing a strip between the field and the sod land. If several deep furrows with sharp sides are plowed, the young hoppers will gather in them and can be killed by daily application of poisoned bait.

#### TRAP STRIPS

Grasshoppers frequently are very abundant in alfalfa and other hay crops at the time of the first cutting. If narrow strips of such crops around the edges of the field and along irrigation ditches are left uncut, grasshoppers from all over the field will gather in them, and can be easily poisoned.

#### BURNING

At night, and even in the daytime during cool weather, grasshoppers seek protection. At such times great numbers of them can often be killed by scattering straw or weeds where the grasshoppers are congregated in the late afternoon and burning it at night after they have crawled into it and become sluggish.

#### POULTRY

Flocks of turkeys or chickens eat great numbers of grasshoppers and can sometimes be used to advantage in small local outbreaks.

#### CATCHING MACHINES

Various kinds of grasshopper-catching machines (fig. 12) have been largely used in the past, but they are no longer recommended unless it is desired to save the grasshoppers for poultry food or fish bait. The poisoned bait is far more effective and is cheaper.

#### IMMUNE CROPS

Some of the sorghums, such as sorgo and kafir, after reaching a height of 8 to 10 inches are practically immune to grasshopper attacks. They can be planted rather late in the season and provide valuable feed for livestock in areas where control measures have not been applied in time to save other forage crops.

### ORGANIZING FOR GRASSHOPPER CONTROL

Where grasshoppers originate on a particular farm and menace only the crops on that farm, individual action is sufficient. If, however, they are present in such numbers that they are likely to move from one farm to another, community and often county-wide action becomes necessary. This can be secured only through proper organization, effective leadership, and adequate financial backing. Lacking any one of these essentials, a large-scale grasshopper campaign cannot be successful. Unless a suitable organization already exists, one should be started. It may well be a farm bureau, farmers' union, community club, or other farmers' organization, headed by an active, efficient chairman. The following type of county organization is suggested:



(1) One executive, the county agricultural agent, if there is one, should be in charge of the campaign for the county. He should be responsible for funds expended, should purchase and apportion supplies, instruct community leaders in the methods to be employed, and make contact with State entomological leaders in order to obtain the latest information on grasshopper control.

(2) There should be community or township chairmen to act as supervisors under the direction of the county leader.

(3) Under these community chairmen there should be foremen of mixing and distributing centers to receive materials, to oversee mixing of materials, and to check out mixed materials to individual farmers and scattering crews.

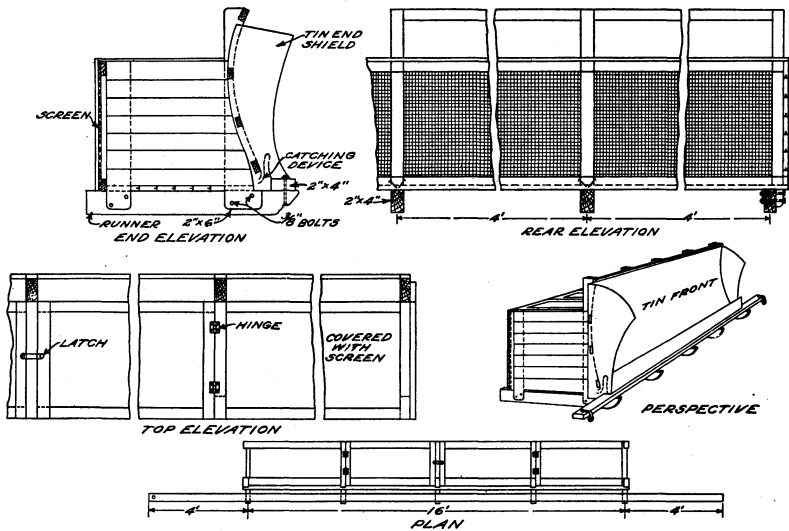


FIGURE 12.—Where it is desired to catch a quantity of grasshoppers to be used as poultry food, the grasshopper catcher is useful. Such a machine may be constructed according to the details shown in this illustration.

(4) Finally, captains of scattering crews, men well acquainted with grasshopper conditions and familiar with the correct method of scattering poisoned bait, should supervise the crews of men who scatter the bait in the field.

Farmers should cooperate and poison all grasshoppers regardless of where they are found. Cleaning up an entire community or township will not only save current crops but will render control measures the following year unnecessary. It should be emphasized that this is not a mere visionary ideal that can never be reached, but is an objective that has frequently been attained. A well-planned campaign, started early and pushed to completion before the grasshoppers are winged, will in most cases prevent serious crop losses; but if action is delayed in order to see what is going to happen or until the grasshoppers are doing serious damage and flying from one field to another, complete success cannot be expected.

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